University of Cambridge
School of Agriculture Memoirs

Memoir No. 33

A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organisations during the period Oct. 1st, 1960—Sept. 30th, 1961

Review Series

No. 16.

Agricultural Plant Pathology in Cambridge—
a Historical Outline

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FOREWORD

This Memoir, which is published under the general editorship of the Librarian of the School, represents an attempt to present as succinctly as possible by means of author summaries the contributions made by members of the Staff of the School of Agriculture and its Associated Research Organisations to the development and progress of Agricultural Science, to indicate to research workers interested the Journals in which the full papers are presented and to act as a complete record of papers published.

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Agricultural Plant Pathology in Cambridge—a historical outline*

by P. H. LOWINGS, M.A., Ph.D.

University Lecturer in Plant Pathology in the Faculty of Agriculture

When late blight of potatoes first ravaged the crops in Ireland, less than one hundred and twenty years ago, it was still widely believed that disease was an act of God and that any small organisms found in association with a diseased tissue were spontaneously generated by its fermentation. It took some fifteen years for the climate of opinion to be changed by de Bary and other mycologists working on diseases of plants and by bacteriologists such as Pasteur working with animals. The potato blight epidemic not only triggered off social revolution in Ireland but it also provided the spur which accelerated studies in the cause and prevention of crop diseases. Progress was relatively slow at first as the organisms causing disease were isolated, classified, and their life histories elucidated. It was not until the 1880's when Millardet discovered the efficacy of Bordeaux mixture in controlling vine mildew that really practical means of controlling crop diseases began to appear. This development coincided with the great agricultural depression which overtook this country towards the end of the last century, and with the realisation that increased productivity could be gained by applying the results of organised scientific research into agricultural problems. It soon became increasingly evident that if new techniques were to be put to good use agricultural education would have to be improved. This led, by a variety of routes, to the introduction of teaching in agriculture at six universities, including Cambridge, in the years 1890–96.

In the early years of agricultural teaching in Cambridge the study of plant diseases, or plant pathology as the new science came to be called, was still the realm of the mycologist, often more nterested in the study of the parasites themselves than in their impact on agriculture. This was inevitable, as until the elementary biology of the parasites was understood it was difficult, if not impossible, to formulate logical control methods. R. H. Biffen was interested in the fungi, but he was even more interested in controlling their attacks on agricultural crops. He is generally remembered as a plant breeder and the breadth of his interests is not always appreciated. Some of his earliest published work was on latex (1, 2) and among his later interests were archaeology (9) and painting (two of his watercolours hang in the conference room of the School of Agriculture). Biffen published several studies on the biology and morphology of fungi (3, 4, 5, 6) while he was developing his plant breeding work. Biffen's parallel interests in pathogenic fungi and in cereals, which were to lead him to produce his famous disease-resistant varieties, are apparent in a paper published in 1905 (7). In this he discusses work by Eriksson and by Marshall Ward on the presence of what he calls "biologic forms" within single species of parasitic rusts, and on the possibility that the pathogenicity of a parasite to a particular host, and the susceptibility of that host, could be altered. He also discusses at some length the possible underlying reasons for the resistance of certain barleys and wheats to attack by mildew and rust. After reviewing the then scanty evidence he concludes that "such facts bring us back once more to the 'constitution' of the plant. Some, from this point of view, are sound, others are wanting, and we look forward to the time when we shall be able to say why this should be so and give those responsible for our crops further aid in, what is rapidly becoming a pressing problem, the raising of disease resistant races." In 1905 Biffen became President of the British Mycological Society for the first time and his presidential address on *Combating the Fungoid Diseases of Plants* (8) reads like a modern lecture on the subject, although we can now look back on achievements that Biffen foresaw as desirable in a possibly Utopian future. He regretted how little research was then being carried out in this country on the control of plant diseases and pointed out that "what little research work on the life histories of these parasites and the most practical methods of keeping them within reasonable bounds is carried out in this country we owe to scientists whose time as a rule is already occupied with educational matters. One can but hope that the future will bring some recognition of the nation's losses year by year caused by epidemics which are frequently preventable and that this may lead to

* *This is the sixteenth of a series of articles summarising phases of agricultural research particularly associated with the School of Agriculture since its inception, previous contributions having dealt with:—Physiology of Reproduction, Plant Virus Research, Plant Breeding, Animal Nutrition, Horticulture, Agricultural Economics, Field Drainage, Animal Production, the Cambridge University Farm, Crop Husbandry, Agricultural Teaching, Entomology and Nematology, Poultry Genetics, Statistics and Soil Physics. Further contributions on other work will appear in future issues.*

the setting aside of a sum of money, small in proportion to these annual losses, for the further study of this subject."

Biffen's plea for an explanation of the underlying causes of disease resistance and susceptibility has still to be fully answered, but more material assistance slowly appeared. In 1912, F. R. Petherbridge was appointed by the Board of Agriculture as Advisory Biologist and stationed in the School of Agriculture. Petherbridge has been called one of the founders of modern applied biology and although he took little part in formal teaching his wide experience and practical outlook on research played an important part in moulding the outlook of young research workers in the school. Although his main interests were in entomology he was, at first, responsible for advisory work in both diseases and pests and he was engaged in some of the early trials of chemical sprays for the control of late blight of potatoes in the Eastern Counties (29). He also applied himself to the problem of controlling club root disease of brassicas (28) and, with A. C. Cole, to the control of gooseberry mildew (32). The volume of work rapidly increased and W. A. R. Dillon Weston was appointed Advisory Mycologist, relieving Petherbridge of his responsibility for work on plant diseases. But even when he was able to give undivided attention to the control of agricultural pests Petherbridge maintained an interest in fungus diseases, especially diseases of orchard trees, and he published papers on apple scab, on silver leaf disease and on apple mildew, both independently and in collaboration with Dillon Weston (30, 31, 33, 34, 35).

Although he was appointed in an advisory capacity Dillon Weston performed a most important educational role in disseminating knowledge of plant diseases not only to farmers but also to schoolchildren and undergraduates by way of his prolific writings. During the twenty years from 1926 to 1946 he published over one hundred scientific and semi-popular papers, articles and books. His educational writings include a series of instructional leaflets which were later incorporated in three booklets (46, 47, 51) much valued by innumerable undergraduates and which have only recently come out of print. The wide circulation of these leaflets is indicated by the frequency with which requests are still received for them, although they have now been replaced by the instructional leaflets of the Ministry of Agriculture, Fisheries and Food. Dillon Weston, in collaboration with R. E. Taylor, also wrote a larger book on *The Plant in Health and Disease* (52) which dealt in greater detail with the theory and practice of plant pathology and was, in part, illustrated by photographs of glass models of fungi constructed by the author, who was an expert and enthusiastic glassblower. In addition to his work as advisor and instructor, Dillon Weston carried out much fundamental and applied research. Throughout his working life he took particular interest in the Bunt disease of wheat, testing many wheat varieties for resistance to the causal organism (37) and carrying out some of the early work on testing seed disinfecting chemicals. He tried many substances, including iodine (38), and later the organo-mercurials (45, 50) which were to replace practically all other chemicals previously used for seed disinfection. A more fundamental line of research was concerned with the action of light on some disease-causing organisms. This investigation later led Dillon Weston to investigate the effect of ultra-violet and other wavelengths (39, 40, 41, 42, 43, 49) on the life and death of various fungi, and was followed by work on the conditions required for the stimulation of sporulation in two fungi, *Helminthosporium avenae* and *Alternaria solani* (44), previously "difficult" in culture. Dillon Weston was a man of great enthusiasms and his published papers reflect his many scientific interests, ranging from investigations in the fungal flora of the upper air (36) to a study of "black spot" of eggs (48). His published work, in itself, provides a history of the advance made in the development of many disease control techniques in the years between the two world wars.

The presence of advisors such as Dillon Weston in the buildings of the School of Agriculture provided the teaching staff with a link with the practical problems of the farmer, while keeping the advisory staff in contact with young research workers studying in the School. The advisory officers often assisted in demonstrating to undergraduates and advising research students, while the university teachers gained by a study of the problems confronting their advisory colleagues. The functions of university teaching and advisory work did not become entirely segregated until the formation of the National Agricultural Advisory Service in 1946. Some of the work of R. M. Woodman, who contributed a previous review in this series (56), provides a striking example of the marriage of fundamental and applied research brought about by the impact of practical problems. During the 1920's many new chemicals were introduced for the control of crop diseases and pests and this confronted both the manufacturers and the users with problems of formulation and

application. Woodman worked in this field for some ten years, carrying out fundamental and applied research in such problems as the physics of spray liquids (54), the creaming of emulsions (53), and the compatibility of fungicides and insecticides (55). This was pioneering work in a field which was subsequently to expand almost to the dimensions of a separate applied science in the research departments of the larger manufacturers of agricultural chemicals.

During the earlier years of plant pathological teaching in the School of Agriculture Biffen was assisted by F. T. Brooks who, after the death of Marshall Ward in 1906, had been left to carry out the teaching of plant pathology in the Botany School and was later to become Professor of Botany. He continued the work on rust fungi of cereals initiated by his brilliant predecessor, but during the period when he was teaching in the School of Agriculture he was especially interested in the silver leaf disease of fruit trees and was working with Petherbridge and Spinks in experiments on American mildew of gooseberries in Cambridgeshire (12). Brooks and his collaborators published much of the research on which our present knowledge of the biology and control of silver leaf is based and investigations in this troublesome disease evidently provided an admirable nursery training for potential advisory officers, as many workers, including G. H. Brenchley, W. C. Moore and H. H. Storey, who later became prominent in the advisory service, cut their pathological teeth while collaborating with Brooks on this problem (10, 11, 13).

By 1933 two separate courses of lectures were being delivered, one to undergraduates and the other to post-graduate diploma students, the latter course of lectures being delivered by Brooks. In that year S. Dickinson arrived in Cambridge and was appointed first as part-time and later full-time lecturer, relieving Brooks of his responsibilities in agricultural teaching and enabling him to devote his full time to his increasing responsibilities in the Botany School. Like Biffen, Dickinson had been fascinated by the problems implicit in the study of the obligate parasites of cereals and had already carried out classic researches in the genetics of smut fungi (14, 15). Also like Biffen, he looked forward to the time when it would be possible to explain why only certain host varieties were susceptible to the attacks of parasites. He applied himself tenaciously to the fundamental problems of determining the stimuli which initiate the mechanisms by which rusts and mildews invade their hosts (16, 17, 18, 19, 20) and adapted his techniques to the study of the entry behaviour of plant parasitic nematodes, inducing them to penetrate artificial membranes (21). This interest in obligate parasites, and in disease resistance, stimulated by Biffen and Dickinson, is reflected in the interests of others working from time to time in the School. M. Keay collaborated with Dickinson in carrying out pioneer work on the nutritional requirements of *Phytophthora infestans*, the organism causing late blight of potatoes (22), while W. R. S. Wortley (57), N. L. Kent (23) and later R. Leach, investigated some aspects of host plant nutrition on disease resistance.

When Dickinson became responsible for diploma teaching in plant pathology the lectures to undergraduates were taken over by J. Line. A First World War pilot, Line carried an essential verve into the lecture theatre, fascinating, instructing and entertaining many generations of undergraduates as he expounded the principles, and his philosophy, of firstly plant pathology and later agricultural botany. For Line taught pathology for only a relatively short period, Dickinson becoming responsible for all plant pathological teaching in 1940 when Line temporarily left the School to play a part in a second war. Although Line had been interested in crop diseases for many years, his first paper describing a characteristically thorough investigation of a disease of redcurrant (26), his major interests were in other aspects of agricultural botany and, after the war, he lectured in this subject until his retirement in 1959. His restless energy has not, however, allowed him to retire peacefully and he is, at the time of writing, actively engaged in work at the National Institute of Agricultural Botany.

After the Second World War, undergraduate numbers increased immensely. The burden of carrying the full load of plant pathology teaching became correspondingly heavy and Dickinson was joined by R. Leach. Leach had wide experience in the tropics and had carried out important work on plantation crops, especially on the control of *Armillaria mellea* (24). While he was in the School Leach maintained his interest in tropical crops and investigated, among other disorders, coconut "nutfall" in the Solomon Islands (25). In Cambridge, he followed what were by then becoming almost traditional studies on disease resistance, studying the influence of nutrition and other factors on the development of chocolate spot disease of field beans. This work was still in progress in 1955, when he accepted appointment as Director of a banana research station in Jamaica.

Leach was succeeded by P. H. Lowings who, during a previous appointment with the Department of Scientific and Industrial Research, had also developed an interest in the mechanisms of disease resistance and has recently been examining the effect of host senescence on the susceptibility of potato plants to late blight (27). This is now being further investigated by studying the potato plant as a nutrient substrate for *Phytophora infestans*.

Plant pathological teaching in the School has always benefited greatly from the co-operation and assistance of other departments, both inside and outside the University. Brooks lectured both in the Botany School and in the School of Agriculture and, to the present day, advanced students of agricultural plant pathology are welcomed to specialist lectures and courses in the Botany School presented by members of the sub-department of Mycology. For many years plant pathologists in the National Institute of Agricultural Botany, in the Plant Breeding Institute, and in the National Agricultural Advisory Service have most generously contributed their time and wide experience to the practical instruction of undergraduate and graduate students. Such contacts are of great benefit to students and Cambridge is especially rich in the wide variety of institutions engaged in various aspects of practical plant pathology. This may become even more important in the future when, in 1962, the first undergraduates to read for an honours degree in agriculture in Cambridge come into residence and are followed, in 1965, by graduates reading for the Diploma in Agricultural Studies which will be launched in that year. The diploma will provide one year of intensive study in a single branch of agricultural science whilst ensuring that a student may have the opportunity of making good deficiencies in his background knowledge of either pure science or agriculture. The presence of such a reservoir of plant pathological knowledge and experience as that represented by the staffs of the diverse institutes in and near Cambridge will be invaluable to these future generations of young specialists.

Although future developments in teaching can be clearly mapped it would be rash to attempt a similar prediction of the future course of plant pathological research in the School, for old studies throw up new problems and progress in science is as liable to sudden changes in direction as the English road and narrow bye-ways are as likely to turn into broad highways. We have still, however, the problem of determining the resistance mechanisms of plants and of putting to use such knowledge as may be gleaned. These studies have, as we have seen, provided a connecting thread for the diverse research carried out through the years on plant pathological problems in the School. This research gains importance when it is realised that it is the staple crops, on which mankind depends quite literally for bread, that provide the most challenging plant pathological problems. Vast acres are covered in these crops, of wheat, rice or maize, but although in aggregate they are so essential, their value per acre is relatively low and, although pests and diseases may steal many thousands of tons, the monetary loss per acre is so little that the plant pathologist is confronted with the problem of controlling disease with the least possible expenditure. One answer lies in the production of resistant varieties, since it costs no more to plant a good variety than it does to plant a poor one. Great strides have been made in breeding plants for resistance but it is possible that with greater knowledge of the mechanisms involved still greater and more lasting advances could be made. The problems have been found to be more complex than was realised, perhaps, at the turn of the century. In spite of this, advances in the physical and chemical sciences have now provided the biologist with tools which may permit us to look forward, with at least as much confidence as Biffen, to the time when the plant pathologist can give "further aid in . . . raising disease resistant races" and help prevent the diseases that have caused loss of crops and famine throughout recorded history.

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AGRICULTURAL ECONOMICS

BARNARD, C. S.

Dairy Herd Grazing Check Sheet. Pp. 11.

Fm Econ. Br. 1961. 1*s.*

This check sheet is an advisory aid intended to enable farmers to assess the part played by grazing in the feed economy of their dairy herds.

1578* BARNARD, C. S.

Principles and Practice in the Management of a Farm Business.

J. Inst. Corn & Agric. Merch. 1960, **8,** 150–4.

The use in farm planning of cost accounts, partial budgets, gross margins and computer programmes is reviewed. The value of the latter in a complex planning problem is illustrated by a case study of a Suffolk farm.

1615* HINTON, W. L.

Capital Needs in Horticulture.

Westminster Bk Rev. August, 1961, 25–30.

In the economic sense all horticulture is intensive—so much so that the value of the land becomes subordinated in the capital structure to investment in glasshouses, heating plant, packing and storage facilities and in the other equipment directly associated with the process of production. In addition new levels of investment bring new levels of current expenditure.

Horticultural products, many of which are luxuries, face a highly competitive market. In this situation capital needs for new investment are considerable, but it is difficult to obtain credit because of the poor value as security of the grower's assets. Marketing is being helped by grants under the Horticultural Improvement Scheme, but many growers cannot raise the required two-thirds of the capital from their own sources. The production side however shows higher marginal returns to capital invested and no government assistance is given here.

The productivity of labour must be increased, and there is still much hope for higher labour productivity in British Horticulture. It would be better if credit were given according to the economic value of the investment and the necessary security for loans should be provided, if need be, by a guarantee from public funds. Without better financial provision, our horticulture will not be sufficiently dynamic to meet competition from abroad, in particular from the Common Market countries, whose success stems partly from their domestic arrangements for credit.

HINTON, W. L. & PLAISTER, A. J.

Potatoes for Profit. Pp. 21.

Mimeogr. Rep. Fm Econ. Br. No. 58. 1960. 2*s.* 6*d.*

Costs and returns were studied in 1958 in four main crop potato districts and in one early potato district in the Eastern Counties. Twenty-seven farms in each district contributed to the main crop results and another twenty to the early potato results in one district only. Average net costs per acre were £96 for both main crop and early potatoes. For main crop potatoes labour and services together accounted for 40 per cent of the costs (two thirds labour and one third services). Seeds and manures accounted for another 40 per cent (two thirds seed and one third manures) and the remainder comprised overheads and rent. For early potatoes seed costs were 30 per cent higher than those for main crop potatoes, and services were lower by a quarter, but other costs (manures, overheads and rent) were similar.

Harvesting operations though a smaller part of the cost give the greatest opportunity for keeping costs down. While high piece work payments for picking are generally popular as a form of annual bonus the progress of mechanisation is slow.

A quarter of the fields had yields below four tons or above twelve tons per acre, but over half had yields between four and eight tons. One in eight main crop potato growers of earlies showed a loss on their crop, but five out of ten growers showed average profits per acre of £78 on main crop and £115 on early potatoes. The 1958 crop was remunerative but subsequent crops have been less profitable.

1596* LATHAM, J. O.†

Some Variations in Beef Production Costs.

Agriculture, Lond. 1961, **67,** 562–7.

The author discusses the value of weighing cattle from time to time to assess the amount of live weight gained on various feeding regimes. He compares beef production costs on a Norfolk arable farm with costs on other farms.

† Present address: Ministry of Agriculture, Fisheries and Food, Christchurch Road, Winchester, Hants

1620* McFarquhar, A. M. M.†

Practical Use of Linear Programming in Farm Planning Involving Problems of Flexibility and Uncertainty in Seasonal Labour Inputs.

Fm Econ. 1961, **9**, 472–96.

A series of optimal farm plans based on data for a given farm in a typical arable area show the increased profit which can be expected from a more detailed consideration of seasonal labour problems than has been possible in planning models.

It is shown that linear programming models can be used to specify the seasonal pattern of work within enterprises subject to other practical limitations. This simulates some of the flexibility in labour use open to the farmer under practical conditions; it is a partial answer to the criticism that the technique of linear programming must assume fixed monthly labour input coefficients for individual enterprises.

A study is made of the uncertainty about times taken to carry out various critical work and an attempt is made to take account of this in the planning models.

The practical potential of linear programming, involving the use of an electronic computer, as a technique which could be used forthwith for planning individual farms is discussed. Comparison is drawn with an alternative method, not requiring the help of a computer, such as programme planning which is likely to be of severely limited value in practice because of the burden of arithmetic involved. Where conscientious consideration of a planning problem does not involve much time spent in arithmetic calculation, techniques based on gross margins or partial budgeting are satisfactory and appropriate in practice.

It is argued that the case that linear programming by computer is too indirect and too costly to use in practice is not proven. No real estimates of cost appear to have been made. On the contrary, tentative estimates presented here suggest that the advantage lies with linear programming which may give better use of skilled resources as well as better farm plans than methods now in use for problems which involve a large section of the farm business.

The types of data used in farm planning are discussed in some detail with relevance to the assumptions on which they are based and the methods of planning for which they are used.

† Until recently Milk Marketing Board Research Fellow.

Nix, J. S.

Economics of Beet Growing. Pp. 105–114.

Contr. to *Sugar Beet Cultivation.* Bull. No. 153, Ministry of Agriculture, Fisheries and Food, London, 1960. 8*s.*

1610* Nix, J. S.

Labour for Cash Crops, 1930–70.

Agriculture, Lond. 1961, **68**, 119–25.

Outlines the decrease in labour requirements for the four main cash crops, potatoes, sugar beet, wheat and barley, over the past thirty years, and attempts to look ahead at what might be achieved by 1970.

Nix, J. S. & Prickett, C. N.

Farm Crop Irrigation. Pp. 44.

Rep. Fm Econ. Br. No. 55, 1961. 4*s.*

This report discusses whether farm crop irrigation is worthwhile, mainly from the farmer's standpoint.

After the need for irrigation and the equipment available are described installation costs are discussed. Up to now, most farmers have been able to obtain "free" water from a river or stream. In such cases capital costs average about £25 an acre irrigated annually. The figure can be as low as £10 an acre if the irrigated area all lies close to a river. Where a borehole or reservoir is needed, however, at least another £1000 will probably be needed and initial costs can exceed £50 an acre. Many factors affect the total cost of an irrigation scheme.

Operating costs average about 45*s.* an acre-inch with "free" water, that is, about £6 an acre. Depreciation and interest on capital account for more than half this sum and can be much higher where expensive source works are needed, possibly making operating costs £10 an acre or even more. Labour and pumping are the main items of running costs, together averaging about £1 an acre-inch.

The data available on yield increases from irrigation are presented. Amongst farm crops, potatoes give the highest return. Sugar beet and grassland irrigation are less profitable but large benefits can nevertheless be obtained on soils prone to drought in the driest areas.

To cover average costs where water is "free" the irrigation-user needs to average an extra three-quarters of a ton of potatoes or one ton of sugar beet. The response may have to be twice this in dry years to compensate for lack of benefit in wet years. Where expensive source works are needed, the average yield increases may need to be twice as high to "break even".

To realise the full potential of irrigation, changes both in farm practices and overall farm planning may be necessary. This applies particularly to grassland; increased use of fertiliser and a large increase in stocking rate are usually needed for a high economic return to irrigation.

If the practice of irrigation spreads rapidly this could have a profound effect on the agricultural economy. Yields should be stabilised but the increase in supplies might lower prices until the acreage falls. This is especially true of crops like potatoes with an inelastic demand. For fruit and vegetables, where an improving standard of living should increase demand, the outlook is more promising.

In future, water supplies are likely to be the chief problem that faces potential irrigators. Already the low summer flow of some rivers in the south-east is causing concern and the control of abstraction from rivers has been recommended by a sub-committee of the Central Advisory Water Committee. More and more new irrigators must therefore expect to have to build farm reservoirs, especially to conserve surplus winter river flows. The Report therefore concludes with a description of the points of importance in the design and construction of such reservoirs.

1601* Selly, C. & Wallace, D. B.

Planning for Profit.

With foreword by F. G. Sturrock. Pp. 19.

Published jointly by the British Broadcasting Corporation and the Cambridge Farm Economics Branch, 1961. 1*s.*

Originally issued as an explanatory pamphlet to accompany three television programmes, it describes a new system of analysing farm accounts and the use that can be made of the results in planning farm reorganisation. This system is known as the Gross Margin System and is based upon the division of costs into two categories, fixed and variable. The deduction of variable costs from the value of the output of any enterprise gives the Gross Margin of that enterprise. Examples are shown of the results for various crops and livestock enterprises and the effect on profits of changes in organisation.

Sturrock, F. G.

Planning Farm Work.

Pp. 135, with 71 Figs and 28 Tables.

Bull. Minist. Agric. No. 172. London, 1961. 7*s.*

This bulletin is an attempt to provide standards for the use of labour in farming. The data is based mainly on a survey of 216 farm enterprises carried out at Cambridge. The contents include:

1. Estimation of labour requirements for the farm as a whole.
2. A description of Work Study methods suitable for the farm.
3. Labour requirements for dairy cattle (with particular reference to milking routines), beef cattle, pigs, poultry and cash crops.
4. Building designs to economise labour.
5. An advisory section with case studies.

1604* Sturrock, F. G.

Progress in British Farming Efficiency.

Distr. Bk Rev. 1961, 1–15.

Sturrock, F. G. & James, P. G.

Report on Farming, 1959/60. Pp. 36.

Fm Econ. Br. Rep. No. 54, 1961. 3*s.* 6*d.*

In addition to the usual report on changes in farming in the Eastern Counties during 1958 and 1959, two other topics of more general interest are included:

(1) A new system of farm business analysis is briefly described. This system, based on Gross Margins, is largely based on research in linear programming. It has now been adopted by the advisory services in the region and the method is expected to spread to other regions in the near future.

(2) Details are given in Chapter 1 of the return on capital on different types of farm. On the whole, the fen farms and the grain specialists obtained the highest return on capital, followed by mixed cropping and arable with dairying. The poorest return was shown by the mixed livestock group. Arable farms adding pigs and poultry obtained incomes about 25 per cent greater than the purely cropping farms but the capital investment was 50 per cent greater.

Wallace, D. B.

Recent Developments in Farm Business Analysis.

Agriculture, Lond. 1961, **68,** 57–60.

A short summary of the new Gross Margin approach to analysis and planning farm organisations. Definitions and examples are given of the main concepts used in this system.

Wallace, D. B.

Resource Use—East Anglian Data. Pp. 85–7.

Contr. to *Scale of Enterprises in Farming.* Appendix D.

Minist. Sci. Nat. Resources (Tech.) Comm. H.M.S.O., 1961. 6*s.*

Figures of inputs per £100 gross output for a constant sample of 240 arable farms are analysed by size groups over two consecutive years. The conclusion is drawn that the pattern of output on the smaller farm is much more dependent upon livestock production than on larger ones and hence there would naturally be differences in the proportion of different *variable* costs, fertilisers and feeding stuffs especially, in relation to size. But the total variable costs per £100 output do not differ with size. The only real difference in *fixed* costs lay in labour, especially the cost of the farmer's manual labour.

WALLACE, D. B.

Scope for Applying Programme Planning Methods.

Fatis Rev. 1961, **8,** 2–5.

A condensation of a paper delivered to an O.E.E.C. Study Conference held at Oslo in September 1960. The use of gross margin planning systems without the aid of a computer by advisory services was considered. They would be most useful in individual farm cases especially where computer time was limited or the advisory services were short of funds. For answers to regional problems and those pertaining to large groups of similar farms, the use of a computer would be far more justified on grounds of accuracy and financial value of the result.

WHETHAM, E. H. & HORAM, J. R.

A Record of Agricultural Policy 1958–1960. Pp. 57.

Occ. Pap. Fm Econ. Br. No. 7. 1961. 4*s.*

This continues for a further two years the record of British agricultural policy contained in the earlier papers in this series. Part I contains an account of the new trading agreements in Europe—the European Economic Community and the European Free Trade Area—in relation to recent policy for British Agriculture.

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1580* JAMES, P. G. The Pedigree Flock. *Agriculture, Lond.* 1960, **67,** 331–6.
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NIX, J. S. More Cash from Cash Crops. *Fmg World.* 1961 (68), 17.
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AGRICULTURAL MECHANISATION

1621* PALMER, J.

Electronic Sorting of Potatoes and Clods by their Reflectance.

J. Agric. Engin. Res. 1961, **6,** 104–11.

The results of analyses of the reflectance properties of common varieties of potatoes and of soil clods are presented, and those properties which are common to all potato varieties and which differ greatly from those of soil clods are discussed. Laboratory experiments with a simple electronic sorter which utilises some of these properties are described.

AGRICULTURE

Brookes, A. J.
The University Farm.
Golden Sheaf. 1961, **11** (1), 12–16.

1612* Hutchinson, *Sir* J. B.
Britain's Contribution to Development in the Tropics. Pp. 20.
Univ. Hull Publ., 1961. 2*s.* 6*d.*
A general survey of the British contribution in technical and administrative services to the development of the tropical territories of the Commonwealth. Territories are classified as Imperial, Colonial or Protectorate, and the problems involved in setting each group on the road towards independence are compared.

1619* Hutchinson, *Sir* J. B. & Bunting, A. H.
A Strategy for the War on Hunger.
Nature, Lond. 1961, **191,** 539–41.
A review of the "Program in the Agricultural Sciences" of the Rockefeller Foundation, 1961, together with a discussion of the factors that limit Britain's contribution to the agricultural development of the tropics.

Momber, E. W.
Systems of Tropical Peasant Agriculture.
Rural Life. 1961, **6,** 3–10.
The theme is that the majority of peasant systems of agriculture are not unsound for the purpose for which they were evolved, namely, to support a subsistence economy in areas where there was no land shortage. Examples are given of these peasant systems and the effect upon them of the challenge of the cash economy which has been introduced in the present century. It is stressed that we still lack much of the knowledge required to meet the demand for greatly increased production in the face of a growing shortage of land.

ANIMAL BREEDING AND GENETICS

1593* Gilmour, D. G.
Blood Groups in Chickens.
Brit. Poult. Sci. 1960, **1,** 75–100.
The genetic basis of the antigens of the red blood cells which determine the blood groups of chickens was worked out in three series of investigations, in all of which iso-immune sera were used. Firstly, Todd established that the antigens were inherited, then Briles and co-workers postulated specific genes determining them, and Gilmour independently identified some of the same loci, and others. Most if not all the loci have multiple alleles. The *B* locus appears to show extreme multiple allelism; the genetic nature of this is discussed in comparison with the Rh series of man and other complex systems. The *A* and *E* systems of the chicken are closely linked (about 1 per cent crossing over) but little is known of the linkage relationships of the antigen loci with other markers, although there is probably at least one antigen locus on each chromosome.

The antigen loci tend to continue segregating at high levels of inbreeding, and there is evidence, at least for some loci, that this is mediated by a heterozygote advantage in survival, with egg production, fertility, hatchability and low mortality as contributory factors.

In outbred populations the antigens are in a state of balanced polymorphism; possible genetic mechanisms accounting for this are discussed in relation to their evolutionary significance.

Because of their connection with survival value, the blood group antigens have some usefulness in commercial poultry breeding.

Hammond, *Sir* J.
Farm Animals: their Breeding, Growth and Inheritance. 3rd ed.
Pp. VIII+322, with 199 Figs and 17 Tables.
(Arnold, London, 1960. 28*s.*)

Hammond, *Sir* J.
Die Verbreitung der verschiedenen Tierarten in der Welt.
Contr. to *Handbuch der Tierzüchtung.* 1961, **3** (1), 56–66.
Ed. by J. Hammond *et al.*
Paul Parey, Hamburg. DM. 88 per vol.

PEASE, M. S.

Die Cambridger Kennhuhnrassen.

Contr. to *Handbuch der Tierzüchtung*. 1961, **3** (2), 353–61.

Ed. by J. Hammond *et al.*

Paul Parey, Hamburg. DM. 88 per vol.

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1616* DUNSFORD, I., LODGE, T., McDERMID, M. & GILMOUR, D. G. **Incomplete Antibodies in Chicken Red Cell Antigens.** *Nature, Lond.* 1961, **190**, 544.

GILMOUR, D. G. **Blood Groups of Animals other than Man.** *Nature, Lond.* 1961, **191**, 653–5.

GILMOUR, D. G. **Bloedgroepen en Pluimveefokkerij.** *Landbouwk. Tijdschr.* 1961, **73**, 268–74.

HAMMOND, *Sir* J. **Future Breeding Policies for the Dairy Herd.** *Spillers Mag.* 1961 (1), 3–8.

1582* HAMMOND, *Sir* J. **Improving the National Herd.** *J. Durham Sch. Agric.* 1961, **2**, 9–11.

POMEROY, R. W. **Why Sows Don't Breed.** *Pig Breed. Gaz.* 1961 (104), 56–7.

ANIMAL NUTRITION

1585* CARPENTER, K. J.

Estimation of the Available Lysine in Animal-Protein Foods.

Biochem. J. 1960, **77**, 604–10.

The Sanger reaction with 1-fluoro-2:4-dinitrobenzene for the determination of the free ϵ-amino groups of lysine units in purified proteins has been applied to animal-protein foods in an attempt to measure nutritional damage which may occur through the formation of enzyme-resistant linkages with ϵ-amino groups during processing.

The dinitrophenyl-proteins were hydrolysed with acid without separation from the digest, and the hydrolysates were ether-extracted. The measure of ϵ-dinitrophenyl-lysine was based on the further decrease in colour in the aqueous layer after digestion with methoxycarbonyl chloride and re-extraction with ether. This procedure gave a nil value for zein and the expected value for insulin.

Twenty-four materials, prepared in most cases as human or animal foods, gave a wide range of values from 1.5 g./16 g. of nitrogen for feather meal to 8.4 and 8.6 g./16 g. of nitrogen for freeze-dried cod fillets and spray-dried blood meal respectively. Recovery of added ϵ-dinitrophenyl-lysine was 92 per cent.

Samples that had been heated and had shown decreased nutritional value in feeding tests also showed lower "available lysine" values in the chemical procedure.

1622* CARPENTER, K. J. & MARCH, B. E.

Availability of Lysine in Groundnut Biscuits used in the Treatment of Kwashiorkor. 2.

Brit. J. Nutr. 1961, **15**, 403–10.

A biscuit meal (C) was prepared from a high-protein mixture, which included 41 per cent of groundnuts and 15 per cent of skim-milk powder. A second meal (U) was prepared in the same way except that the milk powder was not added until after the other ingredients had been baked and milled.

As previously reported (Clegg, 1960), the inclusion of milk powder during the baking of such biscuits resulted in a large proportion of the ϵ-NH_2 groups of the lysine units in the final meal becoming unavailable for reaction with fluorodinitrobenzene.

After correction for losses during hydrolysis and interference from histidine the reactive lysine amounted to 3.6 g./16 g. N (or 3.9 g. by a slightly different procedure) in the (U) biscuits, and to 1.9 (or 2.0) g. in the (C) biscuits.

In a biological assay with young chicks, the live-weight gain/g. food eaten showed that 2.1 g. ($\pm$0.21) more available lysine was contributed from 16 g. N of the (U) biscuit meal than from 16 g. N of the (C) biscuit meal.

The "total lysine" content of acid hydrolysates of the two biscuit meals was 4.0 g./16 g. N for each, as judged by a conventional assay with *Leuconostoc mesenteroides*.

It is concluded that the fluorodinitrobenzene procedure for estimating "available lysine" has been useful for detecting damage to this type of material, but that more work is needed before it can be applied to vegetable materials in general.

1617* EVANS, R. E.

Protein-saving Action of Synthetic Lysine and Methionine.

J. Agric. Sci. 1961, **55**, 111–21.

When synthetic amino acids are added to an all-vegetable diet the amount of nitrogen eliminated in the urine is reduced and the nitrogen retained as tissue protein is correspondingly increased.

The requirements of the weanling pig for essential amino acids have been critically examined, the work involving both growth trials and nitrogen-balance determinations in the metabolism crates.

The addition of synthetic lysine and methionine to a low-protein vegetable diet had a striking effect on the thriftiness of the pigs. It is possible to secure almost as good growth and economy of food conversion on a cereal diet supplemented with as little as 6 per cent ex. soya-bean meal, when the amino acids are added in appropriate amounts, as is obtained on a similar diet containing sufficient white-fish meal to support maximum growth.

By the use of high-protein barley meal, in conjunction with lysine and methionine, it was possible to dispense with protein concentrates altogether without depressing the rate of growth and economy of food conversion.

There is some evidence that although maximum growth is provided for by the standard requirements for essential amino acids this does not necessarily signify that maximum retention of nitrogen will also take place. A minimum of digestible protein is also necessary for the latter purpose.

1592* Evered, D. F.†

Magnesium Absorption in Sheep.

Nature, Lond. 1961, **189,** 228–9.

Feeding a low-phytate, relatively low-magnesium diet to two lambs did not induce hypomagnesaemia in contrast to the use of high-phytate, low-magnesium rations by other workers. Hence, phytic acid apparently antagonises magnesium absorption in the ruminant as in the monogastric animal, that is, the rat.

Oral urea given to the lambs did not lower the blood serum magnesium level, unlike the results obtained with cows receiving ammonium salts via rumen fistulae.

† Now at Department of Chemistry, Chelsea College of Science and Technology, London, S.W.3.

1623* Leat, W. M. F.

Essential Fatty-acid (EFA) Requirement of the Pig. 2.

Proc. Nutr. Soc. 1961, **20,** XVI–XVII.

Using a metabolic lesion as an index of EFA deficiency, it has been shown that the requirement of the pig for linoleic acid is 1 per cent of the total calories.

1600* Leat, W. M. F.

Role of α-tocopherol in the Pig.

Proc. Nutr. Soc. 1961, **20,** III.

1603* Leat, W. M. F.

Studies on Pigs Reared on Diets Low in Tocopherol and Essential Fatty Acids.

Brit. J. Nutr. 1961, **15,** 259–70.

The role of tocopherol in the nutrition of the pig reared from a weaning weight of 10 lb. live weight to a slaughter weight of 200 lb. live weight on a low-fat, low-tocopherol diet has been investigated.

In the first experiment, eight animals were used. Two animals received the basal diet only, two were given a supplement of α-tocopheryl succinate (5 mg./100 g. diet), two of olive oil (2 per cent) and the remaining two animals were given both olive oil and α-tocopheryl succinate. There was no difference in growth rate between the groups and no abnormality in any organs or carcasses at slaughter. Plasma-tocopherol levels were two to seven times higher in the animals given tocopherol than in the controls. There was evidence of a deficiency of essential fatty acids in the animals not receiving supplements of olive oil.

In the second experiment two groups consisting of five animals each were reared on a slightly modified version of the diet used in the first experiment. One group only received supplements of α-tocopheryl succinate (10 mg./100 g. diet). Again, there was no difference in growth rate and no abnormality in any organs or carcasses at slaughter. Plasma-tocopherol levels were seven to thirteen times higher in the animals given tocopherol than in the controls. There was no difference between the two groups in the content of unsaturated fatty acids of back fat, plasma, liver or heart. The peroxide levels in the back fat and liver lipids of the control animals were respectively twenty to fifty times and four to twenty times greater than found in the animals given tocopherol. Again, there were indications of an insufficiency of essential fatty acids in the basal diet.

It is concluded that the major function of tocopherol in the pig is to protect body lipids from oxidation.

ANIMAL PHYSIOLOGY AND ANIMAL PRODUCTION

1599* Brookes, A. J. & Filmer, D. G.

Beef Production from Autumn Born Calves.

J.R. Agric. Soc. 1960, **121,** 46–73.

In 1946 an experiment to investigate the effect of level of feeding and of breed on the growth and fattening of spring born steers was started on the Cambridge University Farm. This showed the fundamental importance of a high level of feeding in the early life of the animal destined for beef, an importance equal for all three breeds of cattle used. This work was followed by another similar experiment on autumn born steer calves which commenced in 1953; the first five batches of cattle have given some interesting information on the effects of breed and of feeding treatment on liveweight, food consumption and profitability, which is reported in this paper.

Three breeds of autumn born steers were used, Hereford × Dairy Shorthorn, Dairy Shorthorn and Friesian. In the calfhood stage four feeding treatments were used and thereafter all cattle were treated alike, on grass in summer and on a moderate level of feeding in subsequent winters. The feeding treatments included a high and a moderate level of calf hood comparable to the high and moderate levels used in the experiment for spring born calves, and also two intermediate levels. The latter were included in an attempt to find out just how well a beef calf should be reared initially to give a satisfactory carcass, coupled with greatest profit, on a system involving the maximum use of cheap bulky foods including grass. Thus for the first three batches of cattle two multiple suckling treatments (one of six months' duration and one of three months) and two pail feeding treatments were used. One of the latter was the moderate level of feeding, and the other was made higher by allowing the calf *ad lib.* concentrates and hay. An early weaning treatment is now being investigated for beef production, and in the two later batches of cattle the high-suckle treatment was replaced by an early weaning treatment (dry-feed).

The results obtained with autumn born calves fully support the earlier conclusion that calves for beef should be done well in the early stages if they are to grow into satisfactory beef animals, with a high proportion of the high priced parts. For full development of hindquarters and loin a generous level of feeding in the early stages is essential. The well reared animal is better able to utilise grass and bulky foods later in life.

With autumn born calves the second six months of life can be spent mainly on grass, but if the calves are to make full use of the grass to produce cheap growth, particularly in wet summers, they must be well reared initially. It is suggested that calves should weigh about 400 lb. at turning out, and this means a growth rate of not less than 1.6 lb. per day in calf hood.

The multiple-suckled cattle grew faster and fattened sooner than the pail fed cattle and tended to catch the better market prices. Although the high-suckle treatment (six months' suckling) produced a slightly bigger animal than the moderate-suckle (three months' suckling) the extra cost was not fully covered; the moderate-suckle cattle were the most profitable, due in large measure to achieving a high rate of gain in calf hood at a moderate cost. The pail feeding treatments produced cattle which were poorer in growth, conformation and profit. The supplementation of bucket feeding with generous amounts of concentrates and hay made little difference to the weight at two-and-a-half years old, although the conformation of the cattle was slightly improved. The dry-feed treatment offers much more promise as a means of rearing beef calves; the limited milk was supplemented by a dry food of high energy value and low fibre content, and this produced cattle with good rates of growth and satisfactory conformation which finished easily.

A growth rate of about 1 lb. a day in the yearling winter was followed by good growth rates in the following summer on grass. At the two-year-old stage a winter liveweight gain of just under 1 lb. a day was followed by gains of 4 lb. a day and over on grass, very cheap growth indeed, and many cattle finished in May and June when beef prices are normally high. In the years in which some cattle finished in winter, these were predominantly multiple suckled animals and either Hereford × Shorthorns or Dairy Shorthorns. The grass fattened cattle showed more profit than those which were finished in yards in spite of being heavier weights, provided that they were ready for slaughter by mid-summer.

The Hereford × Dairy Shorthorns and Friesians produced similar overall rates of growth, but the Dairy Shorthorns were about 1 cwt lighter at two-and-a-half years. The Hereford cross, by reason of its thick coat and hide, stood up well to late autumn grazing conditions, and grew well and finished early in the final summer on grass. It was closely followed in this by the Dairy Shorthorn, but because of its thinner skin and coat the Friesian suffered more setback in late autumn and finally finished a month later off grass than the Dairy Shorthorn.

Full use must be made of suitable autumn born calves for beef, and a generous level of rearing giving rapid growth in the calf stage is essential for success.

1576* Brookes, A. J. & Harrington, G.

Studies in Beef Production. II. Estimation of Live Weight of Beef Steers from Chest Girth and other Body Measurements.

J. Agric. Sci. 1960, **55**, 207–13.

Records collected on the steers reared during the long-term experiment on beef production on the Cambridge University Farm from 1946 to 1955 have been analysed to examine the relation of live weight to various body measurements and the dependence of these relations on breed, treatment and age.

Among the measurements considered singly, chest girth was most closely related to live weight.

There were marked differences in the slopes of the regression lines relating log live weight to log chest girth during the two phases of the experiment—from birth to eight months of age and from eight months to slaughter.

The regression coefficients in the first period were affected by the treatment on which the calves were being reared. Those in the second period were affected both by the level of feeding the steers were receiving during that period and by the manner in which they had been reared to eight months.

Height at shoulder was the measurement which, as a second variate in the regression equations, led to the greatest increases in the accuracy of prediction of live weight. However, the relation of this measurement to live weight was also affected by the treatment.

It was considered that these measurements show little promise as estimators of live weight which could be generally applied, since their relations to live weight were affected by the treatment of the animal.

1602* Brush, M. G.†

Effect of ACTH Injections on Plasma Corticosteroid Levels and Milk Yield in the Cow.

J. Endocrinology. 1960, **21**, 155–60.

In the cow, a single injection of adrenocorticotrophic hormone (ACTH) was found to produce a rapid rise in plasma 17,21-dihydroxy-20-keto-corticosteroids, and then an equally rapid fall. This was followed by a more gradual fall to pre-injection levels which were reached within 24–48 hours of the start of the experiment. The presence of cortisol in the blood samples was confirmed by chromatographic examination. Detectable amounts of other corticosteroids were not found.

The ACTH injections produced a very definite fall in milk yield. Return to generally steady levels took three days in one case and more than seven days in another.

† Present address: Steroid Biochemical Unit, Glasgow.

1598* Hammond, *Sir* J.

Carne: Produccíon y Tecnología. Pp. 160.

Operacíon Carnes. Publ. Téc. No. 1.

Cafade, Buenos Aires, 1960.

HAMMOND, *Sir* J.

Effect of Nutrition on the Stage of Development of the Young at Birth in Farm Animals. Pp. 5–9.

Contr. to Ciba Foundation Symposium on *Somatic Stability in the Newly Born.*

Ed. by G. E. W. Wolstenholme and M. O'Connor. Churchill, London, 1961.

Chronological age does not necessarily coincide with anatomical age. With increased size for age comes more advanced anatomical development for age. The anatomical and the physiological development at birth determine the stability of the newborn and these depend on circumstances occurring during pregnancy. In the embryonic and mid-stage of pregnancy nutrition is obtained by the active agency of the trophoblastic cells and no difference in the development of the embryo is caused by either the number of young present or the nutrition of the mother. During this stage the placenta increases in area and this area determines the amount of nutrition the foetus receives during the succeeding stage when the trophoblast cells degenerate and nutrition is by transfusion. During the foetal stage the nutrition of the mother plays an important part in the proper anatomical and physiological development, and so in the stability of the newborn animal.

HAMMOND, *Sir* J.

Informal Assessment of the Veterinary Significance of the Proceedings. Pp. 333–5.

Contr. to Ciba Foundation Symposium on *Somatic Stability in the Newly Born.*

Ed. by G. E. W. Wolstenholme and M. O'Connor. Churchill, London, 1961.

HAMMOND, J., *Jr.*

Hormonal Augmentation of Fertility in Sheep and Cattle. Pp. 163–91.

Contr. to *Control of Ovulation.*

Ed. by C. A. Villee.

Pergamon Press, London, 1961. $10.00.

HARRINGTON, G.

Quality of Meat with Special Reference to Intensive Methods of Production.

Anim. Prod. 1961, **3**, 223.

Although extensive market research is needed, what evidence we have suggests that modern demand is for lean, tender meat with flavour playing a relatively minor role. This is in marked conflict, in the case of beef, with accepted ideas of a "quality" product, by which "marbling fat" is considered necessary for a high level of eating satisfaction. Well marbled meat is usually accompanied by an undesirable excess of subcutaneous fat. However, acceptance studies show that the correlation between marbling and eating satisfaction is not as high as has been supposed; there are many animals at the lower levels of finish which yield meat of a satisfactory degree of tenderness. Carcasses, underfinished by present grading standards, need not therefore prove unsatisfactory—particularly if young, when their immature flavour will not prove a disadvantage in view of the secondary importance of flavour to the modern consumer.

Since beef carcasses of medium weight are only at a disadvantage if they carry too much fat, the aim of intensive feeding methods should be to produce those animals which will yield the most beef at 12–13 months, provided this is lean tender beef. The results of investigations in this field must be evaluated in terms of the economy of production of lean, tender meat rather than by reference to daily gain and existing grading standards.

Recent studies of the toughness of broilers confirm Hammond's early results with mutton: that steady, fast growth gives the most tender flesh.

1605* HARRINGTON, G. & POMEROY, R. W.

Yields of Cuts from Wiltshire Bacon Sides in Relation to Length and other Carcass Measurements.

Anim. Prod. 1961, **3**, 163–70.

Judges' scores for the "proportion of cuts" of bacon sides were related to the length and to the ratio of the length and depth of the sides, but not to the weight of the fore-end.

In two investigations involving six hundred and eighty sides of bacon, length showed little relation to the yields of the major wholesale cuts or to measures of value based upon them, although in one analysis longer sides tended to have lighter fore-ends. Fatter sides tended to be heavier in the back, and lighter in the fore-end and gammons, than leaner sides of the same weight.

1594* KIRKHAM, K. E.†

Pituitary Gonadotrophins during the Ovulatory Cycle of the Domestic Fowl.

Endocrinology. 1961, **68**, 350–3.

Mature laying hens were killed eight hours before or two hours after ovulation. The pituitary glands were collected at these times, pooled, and their gonadotrophic potency compared. Three bioassay methods were used in making the comparison—the seminal vesicle and uterine weight tests in immature mice and the ovulation test in pregnant mice.

The gonadotrophic potency of pituitaries tended to be higher in birds killed before ovulation than in those killed after ovulation; only in one experiment, however, were the results statistically significant.

The results obtained are compatible with the view that before ovulation a gonadotrophin is released from the pituitary of fowls, but because of the relative non-specificity of the bioassay methods used, it was not possible to determine whether this gonadotrophin was FSH or LH.

† Present address: Clinical Endocrinological Research Unit, The University, Edinburgh.

1606* Latham, J. O.† & Rogers, C.

Influence of Breed and Sex on Carcass Characters of Beef Cattle Bred in Dairy Herds.

Anim. Prod. 1961, **3,** 171–81.

During a survey of beef production in East Anglia carcasses of 163 Friesian, 87 Dairy Shorthorn and 45 Aberdeen-Angus × Friesian steers and 44 Aberdeen-Angus × Friesian heifers were measured and scored by visual assessment for fat development. They were also graded by the Ministry of Agriculture, Fisheries and Food.

Age data indicated that the Friesian steers were, on average, younger at slaughter than the other groups, but data was incomplete and comparison was based on carcasses of the same weight. The Dairy Shorthorn steers had higher mean values than Friesians in three of the carcass measurements taken. The Dairy Shorthorns had a higher average fatness score and a higher proportion of Grade A carcasses. Aberdeen-Angus × Friesian steers had lower mean values for measurements of the hind leg, higher fatness scores and a higher proportion of Grade A carcasses than either of the two pure breeds. Aberdeen-Angus × Friesian heifers had lower mean values for measurements of both fore and hind legs, higher fatness scores and a slightly higher proportion of Grade A carcasses than the steers.

The information gained by use of measurements and fatness scores explained, but did not materially add to, the assessment of the relative value of the groups of carcasses given by grade.

† Present address: Ministry of Agriculture, Fisheries and Food, Christchurch Road, Winchester, Hants.

OTHER PAPERS

1583* HAMMOND, *Sir* J. **Livestock Shows now have a New Look.** *Meat Trades J.* 1960, **180** (3783), 694–5, 697.

HAMMOND, *Sir* J. **Argentina Starts a Policy of Vaccination.** *Fmg Express.* 1961 (46), 12.

1579* HAMMOND, *Sir* J. **Future of Beef Production in the United Kingdom.** *J. Inst. Corn Agric. Merch.* 1960, **8,** 161–6.

BIOMETRICS

1577* Braude, R., Townsend, M. J., Harrington, G. & Rowell, J. G.

Effects of Different Protein Contents in the Rations of Growing Fattening Pigs.

J. Agric. Sci. 1960, **55,** 175–81.

A co-ordinated trial has been carried out at eighteen centres to study the effects of feeding various quantities of high-protein supplement to growing-fattening pigs. In treatment 1, 10 per cent white fish meal was included from weaning to 150 lb. live weight and 3 per cent soya-bean meal was included from 150 lb. live weight to slaughter (approximately 210 lb.). Treatment 2 was the same as treatment 1 except that only 7 per cent white fish meal was included during the first stage. Treatment 3 was the same as treatment 2 except that the rations were changed at 100 lb. live weight instead of 150 lb. Treatment 4 was the same as treatment 3 except that high-protein supplement was omitted altogether after 150 lb. live weight; thus there were three rations involved in treatment 4—7 per cent white fish meal from weaning to 100 lb. live weight, 3 per cent soya-bean meal from 100 lb. to 150 lb. and no high-protein supplement thereafter.

Growth rate and feed conversion both differed significantly between treatments. Pigs on treatment 1 grew 5.0 per cent faster than those on treatment 4; the average growth rate for treatments 2 and 3, the difference between which was negligible, was 3.3 per cent higher than for treatment 4. Feed conversion for treatment 1 was 5.4 per cent better than for treatment 4 and the average for treatments 2 and 3 was 3.8 per cent better than for treatment 4.

Treatment differences were not significant for killing-out percentage, length, quality of fat, proportions of gammon, middle and fore-end of the cured side, thickness of streak, size of eye muscle and amount of fat over it. Some of the fat measurements differed significantly between treatments; differences in fat thickness at the shoulder, middle and rump between treatments 1, 2 and 3 were generally small, but the lowest protein level (treatment 4) resulted in carcasses with about 2 per cent more fat along the back than the average of treatments 1, 2 and 3. These slight differences in back-fat thickness did not result in significant differences in the percentage of pigs in the highest grades.

An economic appraisal of the results suggested that, under the conditions prevailing at the time of the experiment, treatment 3 would have resulted in the greatest profit per year, and the greatest profit per pig. This ration was relatively cheap compared with those of treatments 1 and 2 but it did not lead to a seriously impaired performance, as did that of treatment 4, the cheapest ration.

1590* Mount, L. E. & Rowell, J. G.

Body Size, Body Temperature and Age in Relation to the Metabolic Rate of the Pig in the First Five Weeks after Birth.

J. Physiol. 1960, **154,** 408–16.

Measurements of oxygen consumption have been made in a closed-circuit apparatus on ninety-eight pigs aged from one hour to thirty-seven days. The measurements have been divided into three groups depending on the ambient temperature at which the observation was made and the age of the pig: 30° C. first week, 4° C. first week and 30° C. one to five weeks.

The relation between oxygen consumption rate and body weight, rectal temperature and age has been examined by means of multiple regression techniques, which allow the relation of each of these variables to be assessed separately while the other two are held constant.

In the first five weeks after birth body weight and rectal temperature both had a large effect on oxygen consumption. The effect of age, after allowing for differences in body weight and rectal temperature, was less striking. Indeed, during the first week it was not certain whether it had any effect at all; from one to five weeks metabolic rate and age were negatively related.

The percentages of variance in metabolic rate accounted for by variations in body weight, rectal temperature and age were 86.4 per cent in the 30° C. first-week group, 94.0 per cent in the 4° C. first week group and 88.6 per cent in the 30° C. one to five weeks group.

The small effect of age, when taken with other evidence, suggests that thermogenesis in the pig is well developed at birth.

1618* Richens, R. H.

The Mathematical Assessment of Taxonomic Similarity, including the Use of Computers.

Taxon. 1961, **10,** 97–101.

Report of an informal symposium held at the Botanic Garden, Cambridge, on 6 July, 1960.

1589* Rowell, J. G. & Cooper, D. M.

Some Effects of Diluting Cock Semen.

Poult. Sci. 1960, **39,** 1381–9.

The fertilising capacity of undiluted semen and semen in two diluents, seminal plasma and glycine in distilled water, were studied at three dilution rates, 1:1, 1:2 and 1:3. Fertility was 17.4 per cent lower when the glycine diluent was used, than when seminal plasma was used. Fertility with undiluted semen was similar to fertility with semen diluted 1:1 with seminal plasma. There was a suggestion that dilution had a greater effect on semen from cocks of poor fertilising capacity.

The percentage of spermatozoa taking up nigrosin-eosin stain was higher with the glycine diluent and increased with increasing dilution rate; percentage of stained spermatozoa was lowest when semen was undiluted. Motility differences were not significant.

Only a small part of the damage causing the difference in fertility between the diluents could be measured by the nigrosin-eosin staining technique.

The number of spermatozoa required for good fertility depends on the quality of the spermatozoa and the medium in which they are suspended.

CROP HUSBANDRY

1591* Hanley, F., Jarvis, R. H. & Whitear, J. D.

Effects of Time of Ploughing and Time of Drilling on the Development and Yield of the Winter Wheat Crop following a Clover Ley.

J. Agric. Sci. 1961, **56,** 119–26.

Two experiments designed to investigate the effects of different times of ploughing a clover ley on the growth and yield of the subsequent winter wheat crop are described and the results discussed.

Although the different times of ploughing led to considerable differences in the growth of the wheat, their effect on yield was not consistent. This is in agreement with the results of an earlier series of experiments. The effects of time of ploughing are attributed mainly to the resulting differences in the physical condition of the seed-beds.

Irrespective of ploughing date, a delay of four weeks in drilling the wheat in the autumn, although retarding the growth of the crop, had no effect on yield.

1611* Lazenby, A. & Rogers, H. H.

After-effects of Irrigation.

J. Brit. Grassl. Soc. 1961, **16,** 153–5.

Evidence to show that differences in herbage yields, resulting directly or indirectly from the previous year's irrigation, may be detected in early spring. The effect varied between different plant densities; 76 per cent to 180 per cent increase of dry herbage from the previously irrigated plots. In most densities there was a high mortality on non-irrigated plots. In some densities there was a lower mean yield per plant. The practical significance for the production of early bite is discussed.

1584* Ridgman, W. J.

Effect of Height of Cutting on the Subsequent Growth and Yield of Lucerne.

J. Brit. Grassl. Soc. 1960, **15,** 291–5.

Three experiments designed to test the effect of height of cutting of lucerne on subsequent yield are described and the results discussed. Extremely low cutting, at ground level, can cause the death of individual lucerne plants, but if such extreme cutting is avoided there is no evidence to show any advantage in leaving a long stubble. In fact, in a sward, the lower the cutting the greater is the yield to be expected.

1597* DANIELS, J.

Chaetomium piluliferum **Sp. Nov., the Perfect State of** *Botryotrichum piluliferum.*

Trans. Brit. Mycol. Soc. 1961, **44,** 79–86.

A culture of *Botryotrichum piluliferum* Sacc. × March. isolated from cellulose film previously buried in soil, produced perithecia typical of *Chaetomium* in addition to aleuriospores, phialospores and dark hyphae characteristic of *B. piluliferum.* Ascospores were germinated and formed colonies of *B. piluliferum.* The perithecia were not identified with any known species of *Chaetomium,* and the fungus is diagnosed as *C. piluliferum* sp. nov.

EDWARDS, J. S.†

Spitting as a Defensive Mechanism in a Predatory Reduviid.

Verh. XI Int. Kongr. Entom., Vienna. **B.** III. 1960, 259–63.

The behaviour and structures involved in a defensive mechanism of the predatory reduviid *Platymeris rhadamanthus* Gaerst., involving the ejaculation of toxic saliva are described. Saliva secreted by the two lobes of the principal gland has an action resembling that of snake venom. Since Arthropods are unaffected by topical application of the saliva ejaculated by Platymeris, but vertebrate eye and nose membranes are highly sensitive, it is concluded that in nature the protective mechanism is directed against vertebrate predators.

EDWARDS, J. S.†

Observations on the Ecology and Behaviour of the Huhu Beetle *Prionplus reticularis* **White (Col. Ceramb.).**

Trans. R. Soc. N.Z. 1961, **88,** 733–41.

The phenology and pattern of flight activity is recorded of the non-feeding nocturnal cerambycid *Prionoplus reticularis* White, based on data from emergence cages, light trapping and direct observation. The effect of some environmental factors on light trap captures is discussed. Display, combat, copulation and oviposition behaviour are described. Predators of *Prionoplus* in the Riverhead area are recorded.

EDWARDS, J. S.†

Observations on the Biology of the Immature States of *Prionoplus reticularis* **White (Col. Ceramb.).**

Trans. R. Soc. N.Z. 1961, **88,** 727–31.

Field and laboratory observations on the life history and biology of the immature stages of *Prionoplus reticularis* are recorded. The incubation period is 23 ± 2 days. Hatching behaviour is described. Average duration of the larval stage is considered to be two to three years. Gallery and pupal chamber formation, prepupal and pupal behaviour is described. A Muscardine disease and Mymarid parasite are recorded.

EDWARDS, J. S.†

Action and Composition of the Saliva of an Assassin Bug *Platymeris rhadamanthus* **Gaerst. (Hemiptera, Reduviidae).**

J. Exp. Biol. 1961, **38,** 61–77.

The responses of whole insects, selected organs, and tissues to treatment with the saliva of an assassin bug *Platymeris rhadamanthus* are described.

In the general lysis that follows immobilisation only cuticular and collagenous structures are spared. The disruption of lipid layers in the walls of nervous tissue is histologically demonstrable at an early stage.

The saliva contains at least six proteins, and lacks mucoprotein or other mucoid substance. Three proteolytic fractions were recognised after starch-gel electrophoresis at pH 8.6, one of them forming the major component of the saliva. Attempts to locate a toxic fraction were unsuccessful.

The alkaline endopeptidase activity of whole saliva, characterised with an azocasein substrate, closely resembles gut proteases of other insects examined with the same substrate.

Hyaluronidase is present in the saliva and with protease acts as a spreading factor by breaking down the intercellular matrix.

Lipase and esterase activity were not detected in the saliva, but gut-wall extracts were lipolytic.

The saliva shows weak phospholipase activity. ATP-ase, and serotonin were not detected.

The mode of action of assassin bug saliva as a venom and in external digestion is discussed. It is suggested that its toxicity is due to the disruption of phospholipid layers of the cell wall and is the first manifestation of general lysis during external digestion.

EDWARDS, J. S.†

Anomalous Ovarian Development in *Prionoplus reticularis* **White.**

N.Z. Ent. 1961, **3,** 1.

An example of duplication of ovaries is described.

† Work carried out at the Departments of Zoology, Auckland University, and Cambridge University.

1608* Kennedy, J. S., Booth, C. O. & Kershaw, W. J. S.

Host Finding by Aphids in the Field. III. Visual Attraction.

Ann. Appl. Biol. 1961, **49**, 1–21.

The spectral energy distribution of the light reflected from various leaves and soils has been measured and corrected for "standard" sunlit conditions, and then compared on the basis of Moericke's evidence that aphids of many species distinguish two parts of the spectrum as colours, alighting and probing in response to wavelengths greater than 500 mμ.

Alightments by *Brevicoryne brassicae* and *Myzus persicae* in the field occurred preferentially on leaves reflecting a greater proportion of long-wave energy, with little or no regard for the "botanical" (plant-taxonomic) host status of the plants for each aphid. The colour attraction of such "yellow-sensitive" aphids serves rather to bias their alightments towards plants of the appropriate physiological type.

Laboratory experiments confirmed the existence, inferred from field observations, of a second, non-specific mechanism of visual attraction normally involved in alightments on plants, namely a close-range optomotor reaction with both orientating and arresting components.

The light reflected from various soils embodied maximum energy at the extreme long-wave end of the spectral range affecting aphids, while the leaf energy peak was 540–560 mμ. The predominantly long-wave emission from both leaves and soils contrasts sharply with the light from clear or clouded skies, wherein the peak energy region lies below 500 mμ. The aphids' type of colour vision thus provides for a primary discrimination between sky and ground, beside any subsidiary discriminations among plants and soils.

Low-flying *Aphis fabae* were attracted to white surfaces as well as to yellowing leaves in the field. The change in the migrant's behaviour from "distance flight" in the upper air to low-level "alighting flight" appears to be due, not to a reversal of the response to short-wave sky light from positive to negative, but simply to a relative strengthening of the positive response to long-wave light from the ground.

1587* Moriarty, F.

Laboratory Errors Associated with the Estimation of the Population Density of *Heterodera* Species in Soil.

Ann. Appl. Biol. 1960, **48**, 665–80.

As unexpectedly large sampling errors were obtained in preliminary population studies on *Heterodera*, an examination was made of the laboratory errors associated with sampling for *H. göttingiana* and *H. schachtii*. Soil samples were taken from microplots and appeared to be satisfactory, being without the usual heterogeneity found in sampling from fields. There was little evidence of errors introduced by the techniques used for estimating the number of eggs and larvae in a subsample. These errors, when they occurred, were always small, and this standard technique was deemed satisfactory. The logarithmic transformation was suitable for statistical analysis of both cyst and egg counts.

Apart from the residual variation, there were two other important sources of variation when sampling for eggs. There was a large variation between sub-samples, caused by differences in the number of cysts and in the number of eggs per cyst. There was also in some instances a difference between observers counting the same eggs of up to 20 per cent. Where a comparative measure of density is sufficient, this bias is probably unimportant, and to increase accuracy of estimates of eelworm density, most laboratory work should be devoted to the separation of cysts from the soil sample.

Moriarty, F.

Effects of Red Beet and of *Hesperis Matronalis L.* on a Population of *Heterodera Schachtii* Schm.

Nematologica. 1961, **6**, 214–21.

The effect on a population of beet eelworm of growing *Hesperis matronalis* was tested in microplots in 1956. For comparison, two other treatments were used: fallow, and red beet. Linear regressions of final on initial eelworm densities were made, with modification of the usual analysis to allow for the errors of measurement in the initial population. The rate of decay for eggs with *H. matronalis* increased with higher initial egg density, but was never sufficiently greater than the rate with fallow to be worthwhile for controlling infestations of beet eelworm. Red beet acted as a trap-crop in this year; few if any new cysts were formed, and the rate of decay was similar to that of *H. matronalis*.

Richens, R. H.

A New Stigmellid Leaf Miner.

Nature in Cambridgeshire. 1961 (4), 37–38.

Stigmella fulvomacula (Skala), a leaf-mining moth previously reported from Central Europe, has been discovered in East Anglia and Devon. It mines various species of elm. Its taxonomic relationships with the other elm-mining stigmellids are however obscure.

PLANT BREEDING AND GENETICS

Richens, R. H.

Studies on *Ulmus*. IV. Village Elms of Huntingdonshire and a New Method of Exploring Taxonomic Discontinuity.

Forestry. 1961, **34**, 47–64.

A biometrical study of the leaves of 102 samples is reported. Most of the samples could be assigned to three closely related and one more remote group of *U. carpinifolia*. Sporadic samples of *U. procera* and putative hybrids of

U. carpinifolia × *U. glabra* and *U. carpinifolia* × *U. procera* were also found. The most frequently occurring type of *U. carpinifolia* is thought to be of Roman introduction, Godmanchester being a likely centre of distribution. Most of the *U. procera* in this area appears to date back no further than the eighteenth century.

Some notes on the horticultural variety known as the Huntingdon Elm are included.

A method of treating taxonomic discontinuity quantitatively is described.

SOIL SCIENCE

1588* Childs, E. C.

A Treatment of the Capillary Fringe in the Theory of Drainage. II. Modifications due to an Impermeable Sub-stratum.

J. Soil Sci. 1960, **11,** 293–304.

When a drainage system copes with both artesian and precipitated water the streamline dividing the two flow zones passes through a stagnation point in the medial vertical plane parallel to the drain lines. The approximation is made that the water-table and capillary fringe boundary may be regarded as those appropriate to precipitated water only, in the presence of an impermeable bed passing through the stagnation point. While the absolute heights may be in error it is shown that the partition of the capillary fringe about the water-table location in the absence of a fringe is given with only small error. This partition is calculated from hodograph theory with the aid of Edsac II for combinations of three values of precipitation rate, seven values of fringe thickness, and nine values of depth of impermeable bed. By interpolation, curves are presented to show the partition for combinations of three selected precipitation rates, five depths of bed, and continuous variation of fringe thickness. It is shown that for high precipitation rates the greatest fringe thicknesses are accommodated almost wholly above that surface which would have been the water table in the absence of a fringe, while for the lowest rates of precipitation and zero bed depth only 30 per cent of the fringe is so accommodated; the remainder is below.

1586* Childs, E. C. & Poulouvassilis, A.

An Oscillating Permeameter.

Soil Sci. 1960, **90,** 326–8.

Permeability measurements are made by oscillating a fixed amount of liquid to and fro through a porous column. This allows a small amount of de-aerated water to be used to obtain as many repetitions as may be desired, and the permeability may be calculated by two different applications of the observations.

1614* Childs, E. C. & Youngs, E. G.

A Study of Some Three-Dimensional Field-Drainage Problems.

Soil Sci. 1961, **92,** 15–24.

The Dupuit-Forchheimer approximation has been adopted to deduce relationships between rate of rainfall, soil hydraulic conductivity, and the geometry of the drainage system for three-dimensional systems comprising arrays of pumped wells and rectangular meshes of major and minor drains. The resulting relationships are valid only in those circumstances where the Dupuit-Forchheimer approximation is itself a reasonable assumption, that is for drains or wells penetrating to an impermeable sub-stratum and for small ratios of water-table height to drain separation. A more general treatment, however, relating the performance of mesh drains to equivalent systems of parallel drains, is applicable also to infinitely deep permeable strata and proves to be in agreement with the predictions of the Dupuit-Forchheimer theory.

The theoretically deduced relationships are tested by experiments with drainage systems set up in the hydraulic laboratory of the Unit of Soil Physics, and also by comparison with numerical solutions for particular cases obtained by the relaxation method. Agreement between theory and observation proves to be satisfactory.

1624* Perrin, R. M. S.

Soils. Pp. 44–50.

Contr. to *Norwich and its Region.* Ed. by F. Briers.

Brit. Ass., Norwich, 1961.

A summary is given of previous work on the soils of the county of Norfolk. The processes of soil-formation that have been operative are described, with special emphasis on the effects of the successive glaciations of the region. The soil patterns associated with the main parent materials are explained. The soils of the county are classified in a table and their distribution is shown on a small-scale map.

1607* Towner, G. D.

Influence of Soil-Water Suction on some Mechanical Properties of Soils.

J. Soil Sci. 1961, **12,** 180–7.

The experiments described, using kaolinite, were designed to prove the theory that for a *saturated* soil internal soil-water suction is quantitatively equivalent to an externally applied-all-round mechanical pressure.

1613* Tribe, H. T.

Microbiology of Cellulose Decomposition in the Soil.

Soil Sci. 1961, **92,** 61–77.

Cellulose film was buried in a light sandy soil. A study was made (*a*) on its influence on immobilisation of mineral nitrogen from the soil and subsequent release of nitrate into the soil, (*b*) on the rate and extent of decomposition by estimation of carbon dioxide evolution, and (*c*) on the fate of the cellulose as shown by microscopic examination. The film was added in two forms, as 0.5×1.0 cm. pieces and as powder.

Under the conditions of incubation provided, addition of 0.5 per cent of either form of film resulted in immobilisation of the mineral nitrogen in the soil within two weeks of burial. Nitrate began to be released after sixteen weeks, at about which time maximal immobilisation was calculated. The maximum weight of microbial cells synthesised from the film was calculated to be approximately 10 per cent. Carbon dioxide measurements showed there was a loss of 54–63 per cent carbon corresponding with maximal nitrogen uptake, so that addition of the estimate of carbon bound in bacterial cells indicated 64 73 per cent loss of carbon by the cellulose by this time. The experiment was continued for forty weeks from initial burial, by which time 35 per cent of the maximum nitrogen immobilised by the film pieces was released, and 17 per cent of that from the powder. Final decomposition from CO_2 measurements was estimated at 84 and 72 per cent respectively.

There was a general succession of fungi, bacteria, and protozoa (especially thecate amoebæ) on the cellulose. There was a greater development of fungi on the pieces, to which was attributed the slightly higher rate of decomposition of the pieces. An hypothesis suggested is that mineral nitrogen was taken up by soil organisms until a mature population had developed at approximately sixteen weeks after burial of the film. Thereafter nitrogen was slowly released from the population, which was declining as the cellulose substrate became progressively exhausted. It is suggested that nitrogenous excretion by the protozoa and autolysis of microbial cells were the biological mechanisms of nitrogen release.

The magnitude of the figures for nitrogen immobilisation and release by the cellulose film was similar to those from straw reported in the literature. This confirms the field experience that the return of nitrogen immobilised by cellulosic materials decomposing in soils is small.

Decomposition of the native humus in the untreated soil as measured by the release of carbon dioxide carbon and mineral nitrogen indicated that the C:N ratio in the humus was decreasing rather rapidly.

1595* Youngs, E. G.

Drainage of Liquids from Porous Materials.

J. Geophys. Res. 1960, **65,** 4025–30.

An equation is derived to describe the yield of liquid at a given time from a freely draining column of initially saturated porous material in a gravitational field by using a capillary tube model. The equation is supported by experimental evidence.

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CHILDS, E. C. **Mud—and How the Soil Can be Saved.** *Fmg Express.* 1960 (40), 19.

MISCELLANEOUS

1383* Buttress, F. A. (assisted by Hughes, G. & Barrett, C.).

Abbreviations.

Quart. Bull. Int. Ass. Agric. Libns. 1960, **5,** 186–93; 1961, **6,** 151–8, 217–21.

Supplements Nos. 6 8 to a list of abbreviations of professional, scientific and commercial bodies, not confined to agriculture. Reference may also be made to an earlier work (Buttress, 1954) entitled *World List of Abbreviations of Scientific, Technological and Commercial Organisations,* London: Hill.

Carpenter, K. J.

Research as a Form of Neurotic Behaviour.

Camb. Rev. 1961, **82,** 346–8.

Hutchinson, *Sir* J. B.

Jonah and the Airborne Whale (a visit to Latin America).

Emp. Cott. Gr. Rev. 1961, **38,** 106–10.

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